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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

RESEARCH ASSISTANTS SUPPORTED BY THIS GRANT HAVE WORKED IN A VARIETY OF OPTICAL COMPUTING
PROJECTS. THESE PROJECTS ARE SUMMARIZED BRIEFLY IN THIS REPORT.

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Integrated Opto-Electronic Computing Final Technical Report

This is the final report on Contract AFOSR-88-0211. The report covers the period from 7/1/88 to 1/31/89.

The research assistants supported by this research contract have worked in a variety of optical computing and optoelectronic computing projects. These projects have included:

Dynamic Optical Interconnection Networks with Integrated Optoelectronic Transceivers

A design has been developed for an optical multi-stage omega network suitable for interconnecting a 2-D plane of inputs to a 2-D plane of outputs. The network requires optical components to perform the shuffling and optoelectronic switching modules, which are dynamic, electrically controlled 4 x 4 crossbar networks that route any of four inputs to any of four outputs in the sense of a one-to-one permutation (no many-to-one [wire-or] or one-to-many [broadcasting] routings are needed). The output of the 4 x 4 switching modules are optical signals that are routed in 3-D by a set of interconnection optics and free-space propagation to succeeding stages containing switching modules.

Ultralow Threshold Laser Arrays

A low threshold laser design utilizing only a single growth step on an etched substrate to define a narrow active region has been developed. Stable, single mode operation with threshold currents as low as 3.4mA (pulsed, room temperature) and 3.8mA cw has been achieved in unoptimized devices grown in this manner by MOCVD. These devices, when coated to increase the reflectance of the mirror facets, should operate at threshold currents below 1mA.

Array Receivers for Optical Interconnections

During the last year, very low power receivers and logic circuits for high density interconnects have been emphasized. On the analytical side of the effort, a comprehensive model of InGaAs and InP JFETs has, for the first time, been developed.



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Experimentally, fabrication technologies for both detectors and transistors needed for the array receivers have been investigated. In addressing the issue of crosstalk, the concept of remote, optoelectronic powering and switching of functional array pixels have been introduced. This concept relies on the ability to fabricate low power dissipation transceivers which minimize the use of inductive power supply and address interconnects via the use of integrated photovoltaic power cells.

Optical Interconnects using Waveguide Coupled Photodiode Arrays

During this reporting period, a high bandwidth organic-on-inorganic semiconductor photodetector for eventual integration into waveguide coupled arrays has been successfully demonstrated. The photodetectors consisted of a GaAs or Si substrate on which was deposited 2000Å of PTCDA followed by approximately 1500Å of ITO which formed a transparent ohmic contact to the PTCDA. The Si-based detector had an avalanche breakdown voltage (accompanied by photocurrent gain) of 55V, and a primary reverse current density of $0.9V_B$ of approximately 10^{-5} A/cm^2 . Also, the external quantum efficiency had a maximum of 85% at a >10V reverse bias, and at a wavelength of 0.8µm.

Optical Processors for Neural Computation of Image Understanding Algorithms

The central goals of this research are: 1) to develop efficient algorithms for several Computer Vision problems that can be implemented on artificial neural networks, and 2) to investigate optical implementation of these special purpose neural networks. Over the last 12 months, we have developed and experimented with an 1) algorithm for the extraction of 3-D information from two stereo images, and 2) algorithm for the computation of optical flow.

The algorithm for matching stereo images uses neural network for matching the estimated first derivatives under the epipolar, photometric and smoothness constraints. Derivatives are estimated using polynomial fits in a local window. The algorithm for computation of optical flow matches estimates of principal curvatures obtained from a local window. A neural network is employed to match the estimated principal curvatures under local rigidity and smoothness constraints.